ORIGINAL

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of:	
1998 Biennial Regulatory Review -- Amendment of Part 18 of the Commission's Rules to Update Regulations for RF Lighting Devices	ET Docket No. 98-42

Comments of Satellite CD Radio, Inc.

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SUMMARY

The *NPRM* proposes to update Part 18 of the Rules to permit the introduction of microwave radio frequency (RF) lighting devices. These devices emit microwave radiation to stimulate gases in a lamp, which produces light. CD Radio seeks rules that will protect the satellite digital audio radio service ("Satellite DARS") from harmful interference by RF lights operating in a frequency band near that of Satellite DARS. Satellite DARS will transmit nationwide radio programming with compact disc quality sound to a consumer mass-market, particularly in cars. RF lights on highways (a likely application) can radiate significant microwave energy directly into Satellite DARS car antennas.

The *NPRM* contains almost no information about the radiation characteristics of RF lights and their interference potential for Satellite DARS. Thus, the FCC should not amend Part 18 as proposed without a sufficient record to evaluate the interference. The limited information available on RF lights suggests that operation under the proposed rules is likely to cause severe interfere to Satellite DARS. This would unfairly impair the usability of CD Radio's license, purchased from the government in an auction for millions of dollars. Also, it would be inconsistent with the public interest, and the non-interference conditions in Part 18, for the FCC to authorize an unlicensed technology knowing that it would harm an already authorized radio service.

CD Radio's preliminary analysis demonstrates that the proposed rules for RF lights would not suppress emissions adequately. For example, with realistic assumptions, a microwave RF light would radiate unwanted energy into the bandpass of an Satellite DARS receiver that would unacceptably increase the noise floor by 25 dB (for "non-consumer" devices) or 19 dB (for "consumer devices"), either of which substantially exceeds six percent (about 12

dB below the noise level)—the International Telecommunication Union's ("ITU") long-standing threshold of potentially harmful interference to satellite radio services. Furthermore, this analysis applies only to a single RF light; there may often be many RF lights simultaneously interfering with Satellite DARS reception. This additive effect must be considered in developing out-of-band limits.

The FCC's authorization of the Wireless Communications Service ("WCS") has already significantly increased the noise that could be experienced in the Satellite DARS spectrum. The cumulative effect of (possibly multiple) RF lights operating within the proposed field strengths could cause serious harmful degradation of the Satellite DARS signal. Moreover, the proposed rules, which set the out-of-band emission limitation for RF lights as a field strength, rather than a power spectral density, understate the potential interference to wide-band services such as Satellite DARS.

The different field strength limits proposed for "consumer" and "non-consumer" RF lights will not work in the real world. "Non-consumer" RF lights illuminating highways or industrial parks would have a far greater potential for deleterious effects on Satellite DARS reception in automobiles than, for example, microwave ovens or personal computers in homes. Thus, the out-of-band limits for RF lights should assure the public of satisfactory Satellite DARS reception regardless of whether they are in commercial or residential locations.

CD Radio requests that the FCC seek additional information from proponents of RF lighting prior to further consideration of rules, including spectrum graphs with measurement details as well as information on out-of-band suppression techniques such as filtering, shielding, and the orientation of the microwave emissions.

In view of the foregoing, the FCC should decline to adopt the proposed rules at this time.

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Satellite CD Radio, Inc. ("CD Radio") comments in the above captioned proceeding, which proposes to amend Part 18 of the Federal Communications Commission's ("Commission" or "FCC") Rules to update regulations for radio frequency (RF) lighting devices.[1] CD Radio's principal interest in this proceeding is to ensure that out-of-band emission limits be adopted for RF lighting devices operating in the 2400-2500 MHz (2450 MHz) frequency band that adequately protect satellite digital audio radio service ("Satellite DARS") operations in the nearby 2320-2345 MHz frequency band.

Specifically, CD Radio requests that the Commission not adopt rules until lighting manufacturers supply definitive information on the record necessary to evaluate RF lighting interference to Satellite DARS and the Commission and the public have an adequate opportunity

[1] 1998 Biennial Regulatory Review – Amendment of Part 18 of the Commission's Rules to Update Regulations for RF Lighting Devices, ET Docket No. 98-42, 63 Fed. Reg. 20,362 (Apr. 9, 1998) ("*NPRM*").

to evaluate this information. If the Commission proceeds with the adoption of rules in the absence of more detailed information about the radiation characteristics of RF lighting devices, however, stringent emission limits must apply to these devices in order to protect adjacent radio communications services, including Satellite DARS. In particular, the Commission should ensure that out-of-band emissions from RF lighting devices do not exceed the International Telecommunication Union's ("ITU") long-standing threshold of potentially harmful interference to satellite radio services unless a careful and thorough analysis demonstrates that a higher level of emissions will not be harmful to Satellite DARS.

I. CD Radio And The Satellite DARS Service

CD Radio is one of two licensees authorized by the FCC to launch and operate Satellite DARS in the United States.[2] Satellite DARS is a radiocommunication service that will provide continuous nationwide radio programming with compact disc quality sound to a consumer mass-market.[3] CD Radio's Satellite DARS will provide uninterrupted programming to audiences traveling in vehicles, niche programming to listeners with special interests, and a wide range of audio programming options to rural and mountainous sections of the country that have been historically underserved by terrestrial radio. Indeed, the Commission has concluded that Satellite DARS will "yield substantial benefits to consumers."[4] For example, the Commission has

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[2] Satellite CD Radio, Inc., Application for Authority to Construct, Launch and Operate Two Satellites in the Satellite Digital Audio Radio Service, DA 97-2191 (Oct. 10, 1997) ("*CD Radio Authorization*").

[3] The Commission defines Satellite DARS as "[a] radiocommunication service in which audio programming is digitally transmitted by one or more space stations directly to fixed, mobile, and/or portable stations, and which may involve complementary repeating terrestrial transmitters." 47 C.F.R. § 25.201 (1997).

[4] Establishment of the Rules and Policies for the Digital Audio Radio Satellite Service in the (Continued...)

acknowledged that Satellite DARS will "offer high quality radio signals to listeners who currently receive few terrestrial radio signals."[5] Moreover, with its national reach, Satellite DARS will "complement terrestrial radio"[6] by "provid[ing] new services that local radio inherently cannot provide...[such as] continuous radio service to the long-distance motoring public...and new forms of emergency services"[7] In addition, Satellite DARS will "foster niche programming because it can aggregate small, nationally dispersed listener groups that local radio could not profitably serve."[8]

To bring such important new radio offerings to the listening public, the FCC adopted rules on March 3, 1997 to auction two 12.5 MHz Satellite DARS authorizations in the 2320-2332.5 MHz and 2332.5-2345 MHz frequency bands.[9] Shortly thereafter, CD Radio submitted a winning bid of $83.3 million dollars for a license to launch and operate a Satellite DARS system in the 2320-2332.5 MHz frequency band.[10] CD Radio submitted a formal amended application[11]

(...Continued)
2310-2360 MHz Frequency Band, 12 F.C.C. Rcd 5754, 5762 (1997) ("*Satellite DARS Order*").

[5] *Id.* at 5759.

[6] *Id.* at 5756.

[7] *Id.* at 5760.

[8] *Id.* at 5761.

[9] *See Satellite DARS Order, passim.*

[10] The Satellite DARS auction raised a total of $180 million dollars. *See* Public Notice, "*FCC Announces Auction Winners for Digital Audio Radio Service*," DA 97-656, Report No. AUC 97-05 (Apr. 2, 1997).

[11] Satellite CD Radio, Inc. Application to Launch and Operate a Digital Audio Radio Satellite Service in the 2320-2332.5 MHz Frequency Band: Submission and Amendment to Application
(Continued...)

and received its license in October of last year after paying the entire $83.3 million dollars into the United States treasury, without any deferred payments.

CD Radio has already contracted for delivery of the satellites and expects to commence launching them toward the end of next year—three years ahead of scheduled milestones. At that time, CD Radio will begin to serve millions of consumers who listen to radios in their cars every day. CD Radio's system will employ a roof or rear window-mounted antenna, approximately 6 cm in diameter, on each vehicle, which will be from 1 - 6 meters from the ground, depending on the size of the vehicle. CD Radio's non-directional antenna provides excellent mobile reception, and has a gain of between +3 and +5 dBi.

By these comments, CD Radio seeks to ensure that the public receives high-quality and diverse radio programming free from harmful interference by RF lighting devices, and to protect its own substantial contribution toward the development of Satellite DARS.

II. The RF Lighting NPRM

In the instant proceeding, the Commission proposes to update its Part 18 rules to permit the introduction of a new generation of RF lighting devices. RF lighting uses radio energy to stimulate gases contained in a lamp to produce visible light. Earlier RF lamps employed "exciters" that operated at frequencies about 150 kHz. The next generation systems, some of which have already been tested *in situ*, are likely to operate in the 2.5 MHz band or in the allocation for "industrial, scientific and medical" (ISM) devices at 2450 MHz.

(...Continued)
of Satellite CD Radio, Inc., 71-SAT-AMEND-97 (May 16, 1997) ("*CD Radio Amendment*"); Application of CD Radio, Inc. for an All-Digital CD Quality Satellite Sound Broadcasting System, File Nos. 49/50-DDS-P/L-90 (May 18, 1990) ("*CD Radio Application*").

Proponents of these devices suggest that the new generation of RF lighting will be significantly more energy and cost efficient than current products. As such, the Commission expects "RF lighting devices to proliferate."[12] If the current installations in Washington, D.C.—described in the *NPRM*—are any indication, one of the most important uses of RF lighting will be "outdoor lighting, such as street lighting,"[13] with lamps possibly only a meter or so above where Satellite DARS mobile antennas can be expected to be. In view of this, it is critical that the agency establish, *ab initio*, rules that protect existing radiocommunication services operating in nearby spectrum.

As the Commission notes, current RF lighting regulations do not limit radiated emissions, either in-band or out-of-band. Accordingly, the *NPRM* suggests imposing limits based on those established for "Part 15" unlicensed radio emitters. The Commission proposes to retain the ISM dichotomy between consumer and non-consumer devices, and import the Part 15 "Class A" and "Class B" field strength levels for such purpose.[14]

Recognizing that the proposed limits—and the division between "consumer" and "non–consumer" devices—have been arrived at without significant interference analysis, the Commission "seek[s] comment on whether these limits are adequate to protect against interference to communications services that may be caused by RF lighting products."[15] Such

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[12] *NPRM*, ¶ 13.

[13] *Id.*

[14] The proposed rules, however, change the required measurement distance to 30 meters—apparently to remain consistent with current Part 18 rules, rather than use the 3 and 10 meter distances in Part 15.

[15] *Id.*, ¶ 12.

comments are especially important where, as the *NPRM* states, one of the proposed types of RF lamps "radiates significant RF energy across a broad range of microwave frequencies."[16] Indeed, the Commission appeared "particularly concerned that this energy could cause interference to...the Digital Audio Radio Service"[17] approximately 100 MHz below the center frequency of the proposed lighting devices.

III. The Commission Should Not Adopt Proposals To Implement A Widespread, Unlicensed Technology That Has The Potential For Severe Interference With Licensed Radio Communications Services

CD Radio appreciates the potential benefits that the next generation of RF lighting could provide to the American public. However, the FCC's mission remains "to maintain the control of the United States over all the channels of radio transmission"[18] and to "make reasonable regulations. . .governing the interference potential of devices which in their operation are capable of emitting radio frequency energy. . .in sufficient degree to cause harmful interference to radio communications."[19] As a result of this mandate, it would be inconsistent with the public interest for the agency knowingly to authorize a technology that will undermine other radio services. Indeed, the FCC's normal practice is to insist that new technologies and services avoid harmful interference to existing allocations.

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[16] *Id.*

[17] *Id.*

[18] 47 U.S.C. § 301 (1992).

[19] 47 U.S.C. § 302a(a) (1992). *See also* 47 C.F.R. § 18.101 (1997) (FCC has authority "to prevent harmful interference to authorized radio communication services.").

This is particularly true for a service, like Satellite DARS, that seeks to serve a mass, consumer audience. Although no licensee, including CD Radio, should expect a pure, interference free environment, neither should a licensed service provider – especially one that has committed and/or invested over one half billion dollars to date in its infrastructure – be required to accept significant degradation in its signal quality from unlicensed devices. As the Commission itself has noted:

> In authorizing DARS, it was our desire to ensure a high quality radio service. Accordingly, our intention in determining out-of-band emission limits . . .has been to limit the potential for interference to a reasonable level. . . Such limits are necessary to ensure the viability of Satellite DARS, which will operate with very low signal levels at the receive antennas, in a frequency band adjacent to a terrestrial service that will likely employ much higher powers and whose transmitters may be in the immediate vicinity of a DARS receiver. . . [I]f Satellite DARS in this spectrum is subject to excessive interference, the service will not be successful and the American public will not benefit from the service.[20]

The Commission's admonition is especially applicable where, as here, Satellite DARS service has just been authorized and will shortly be required to debut in the marketplace. Any unreasonable interference to CD Radio's transmissions could bias the public, and imperil this major new service from the start.

At this stage, the record does not contain sufficient and specific information as to the interference potential of proposed RF lighting devices to permit the Commission to adopt its proposed rules. CD Radio's preliminary analysis shows that proliferation of RF lighting devices that merely comply with the proposed rules will severely interfere with the Satellite DARS signal

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[20] Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service, 12 F.C.C. Rcd 3977, 3991 (1997) ("*WCS Reconsideration*").

received by radio users. CD Radio has attached to these comments its technical examination of this issue, which provides the engineering support for its conclusions, and raises additional questions about interference standards and measurement techniques. However, apart from these specific concerns, CD Radio believes that there are two general weaknesses in the Commission's current proposal.

First, adoption of the suggested rules would lead to chaos. The Commission, and lighting manufacturers, expect deployment of millions of RF lights. As ISM devices, these lights would not be licensed—even the Commission would be unaware of the location of each RF emitter. Even if authorized on a non-interference basis—as Part 18 ISM equipment must be[21]—it often would be impossible to track the source of any particular interference into mobile receivers, much less eliminate the source of that interference.[22]

The foregoing is particularly true because the *NPRM* proposes only per-device emission limits. However, the interference environment will be characterized by tens or even hundreds of RF lighting devices potentially in line-of-sight with a Satellite DARS receiver. Neither the RF lighting manufacturers nor the FCC have quantified and made public the effects of multiple interference into Satellite DARS, despite the fact that such "multiple entry" analysis is standard procedure in the satellite services.[23]

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[21] 47 C.F.R. § 18.109 (1997).

[22] When the source could be tracked, there would be the potential for disagreement as to a remedy. Thus, the Commission easily could become embroiled in controversy as communities deploy microwave RF lighting for street illumination only to learn that their investment has violated the "no interference" provisions of Part 18 and has resulted in complaints of widespread interference.

[23] For example, the two degree spacing analysis required of satellite applicants, *see* 47 C.F.R. § 25.140(b)(2), mandates consideration of multiple sources of interference.

Second, the proposed rules would be unfair. CD Radio, and other nearby adjacent channel licensees, have paid hundreds of millions of dollars at auction for access to their frequency bands. The Commission should not unreasonably degrade the quality of the spectrum once auctioned. Indeed, the *NPRM*'s current proposal would defeat the reasonable, investment-backed expectations that enabled CD Radio to raise finance and secure a license; any such change in spectrum policy would breach the enforceable agreement between the FCC and CD Radio.[24] Such a change also could be considered a "taking," giving rise to a claim for "just compensation."[25]

RF lighting systems, like any ISM device, are required to be designed "with sufficient shielding and filtering to provide adequate suppression of emissions on frequencies outside the [center] frequency bands."[26] As explained below, CD Radio's preliminary analysis demonstrates that the proposed rules for RF lights do not meet this standard. Accordingly, the Commission should decline to adopt the rules absent more information or more stringent limitations on out-of-band emissions.

IV. The Commission Should Revise Its Proposed Out-Of-Band Emission Limits For RF Lighting To Implement A Standard That Adequately Protects Against Interference

As proposed, the limits that would apply to microwave RF lighting fail to provide a realistic assessment of the unwanted energy that will fall within the bandpass of a DARS mobile

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[24] *United States v. Winstar,* 518 U.S. 839 (1996) (finding government liable for breaching the obligations it undertook to induce private actors to make certain purchases).

[25] *See, e.g., Penn Central Transportation Co. v. New York,* 438 U.S. 104, 124 (1978) (identifying as a taking a government action that, *inter alia,* "interfere[s] with distinct investment-backed expectations.").

[26] 47 C.F.R. § 18.109 (1997).

receiver, for two reasons. First, setting the out-of-band emission limitation as a field strength—rather than a power spectral density—will understate the interference to wide-band services such as Satellite DARS. Interference to DARS mobile receivers is determined by how much unwanted energy falls within the bandpass of the receivers. If one assumes that the DARS receiver has a bandpass of 12.5 MHz, then the real issue becomes how much undesired energy (*i.e.* radio pollution or noise) from out-of-band RF microwave lighting emissions should be allowed to fall within a DARS receiver's bandpass. In other words, what is really needed is a power spectral density specification. While the imported Part 15 field strengths implicitly carry with them the requirement that the measurements be made with a resolution bandwidth of one megahertz,[27] this still fails to answer the inquiry as to how much undesirable energy the mobile DARS receiver should be forced to accept if a reasonably high quality service is to be provided.

Second, the Commission has inappropriately drawn an analogy between RF lighting devices and microwave ovens in setting its limits. This is a false comparison. Microwave ovens are employed indoors, not mounted on poles overlooking streets in close proximity to Satellite DARS mobile receivers. Moreover, microwave ovens are used intermittently. In short, despite the proliferation of microwave ovens, microwave RF lighting has a far greater potential for deleterious effects on DARS reception in automobiles.

Given the foregoing methodology, it is no surprise that the suggested RF lighting rules would be likely to create harmful interference to the Satellite DARS services. As described in

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[27] The measurement procedures for ISM devices set forth in OST-5 also specify a resolution bandwidth of one megahertz. Federal Communications Commission, Methods of Measurements of Radio Noise Emissions from Industrial, Scientific and Medical Equipment, FCC/OST MP-5, § 2.2.2 (Feb. 1986).

the attached Technical Appendix by W.L Pritchard & Co., the proposed permissible out-of-band emissions limit set forth in the *NPRM* greatly increase noise levels for DARS reception. Indeed, at the proposed levels, the internationally recognized threshold for coordination of systems would occur at 682 meters from a single RF microwave lighting device. This would be unacceptable and impractical, particularly given the placement of Satellite DARS antennas on top of vehicles, and the planned proliferation of RF lighting in street lamps. In short, the stage would be set for serious, often debilitating, service degradation.

The ITU normally considers interference to be significant when a new system raises the noise temperature of an existing digital system by six percent (*i.e.*, 6% $\Delta T/T$ (about 12 dB below the noise level)). Thus, a proposed new radiocommunications system would be recognized as potentially causing harmful interference, and thereby be required to coordinate with an existing digital satellite service, if the proposed system would raise the noise floor by 6%.[28] As noted in the Technical Appendix, an RF lighting device within a short distance of a Satellite DARS receiver would clearly exceed this ITU-R coordination threshold.[29] Indeed, under the *NPRM's* rules, a microwave RF lighting system operating in compliance with the proposed out-of-band emissions limits would be allowed to radiate unwanted energy into the bandpass of the DARS receiver that would result in the noise floor being raised by 25 dB (for "non-consumer" devices) or 19 dB (for "consumer devices"), either of which substantially exceeds the -12.2 dB that would correspond to a 6 percent increase.[30]

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[28] *See* ITU-R Recommendation 523.

[29] In its license application filing, CD Radio has employed a system noise temperature of 167° K.

[30] The Technical Appendix suggests that field strengths from a single RF lighting device greater than 4 μV/m (at 10 meters) would exceed the ITU coordination threshold. Of course,

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In authorizing the Wireless Communications Service,[31] the Commission has already significantly increased the noise that could be experienced in the Satellite DARS spectrum. The effect of microwave RF lighting devices operating at the proposed field strengths could prove to be much more deleterious. As the attached Technical Appendix notes, the amount of degradation forced on Satellite DARS operations in the WCS proceeding would increase the noise floor by 1 dB by reducing the ratio of interference power/Hz to noise power/Hz from -12.2 dB to -5.8 dB. Thus, if -5.8 dB were employed as the threshold for coordination, a single microwave RF lighting device operating at the proposed out-of-band field strength level would need to be 325 meters removed from the Satellite DARS receiver in order not to raise the noise over the threshold. Even a -5.8 dB I_0/N_0 threshold could prove to be inappropriate because of the cumulative adverse effects of undesired signals from multiple RF lighting and WCS devices that could interfere with a Satellite DARS transmission.

V. The Commission Should Eliminate Its Proposed Consumer/Non-Consumer Dichotomy

The *NPRM* proposes a distinction between RF lighting used in consumer equipment and that employed in non-consumer equipment. This distinction is partially codified in the existing Part 18 Rules which define *consumer ISM equipment* as

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interference from multiple RF lights would be cumulative, suggesting that any emission limit be set well below such a figure. In any event, the analysis contained in the Appendix is conservative in that it considers only the typical Satellite DARS antenna gain (+3 dBi), not the maximum gain (+5 dBi).

[31] Wireless Communications Service, 12 FCC Rcd 10785 (1997), *recon. in part,* 12 FCC Rcd 3977 (1997).

> A category of ISM equipment used or intended to be used by the general public in a residential environment, notwithstanding use in other areas.[32]

There is no corresponding definition of "non-consumer ISM equipment." Instead, the implication is that non-consumer equipment is that not intended for use in a residential environment. In this respect, as the *NPRM* notes, the consumer/non-consumer distinction has been imported from the Part 15 digital device regulations.

CD Radio submits that this distinction in the context of microwave lighting and interference to Satellite DARS makes no sense. The rationale for the Part 15 digital device distinction rests on the assumption that commercial and industrial locations are less likely to have broadcast receivers in close proximity to Part 15 digital devices. However, Satellite DARS receivers will primarily be mounted on vehicles that will drive in both commercial and residential neighborhoods. Thus, in the microwave RF lighting context, interference to mobile reception can be expected to be the same in both commercial and residential areas.

With microwave RF lighting used for illuminating commercial exteriors and for street lighting, the Commission can expect a plethora of interference sources lining the streets on which a Satellite DARS equipped vehicle would travel. Thus—unlike computers subject to the Part 15 rules, which generally are within buildings—the microwave RF lighting noise emitters would be only a few meters away from automobiles that would be equipped with Satellite DARS receivers, and without any attenuating walls. To the extent that the physical relationship between the protected receiver and the interfering source are one factor in determining the likelihood of interference, the widespread deployment of microwave lighting at the out-of-band limits

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[32] 47 C.F.R. § 18.107(g) (1997).

proposed would present a worst case. The FCC could expect whole cities and literally miles of highways to be covered with high levels of RF noise across the bandpass of DARS receivers. Indeed, if the cost of microwave RF lighting drops, it will likely be employed for residential outdoor lighting for recreational and security purposes as well. This will only compound the interference problem.

In short, when the adverse impact on a nationwide service intended to be received by the public in vehicles such as DARS is considered, there can be no meaningful distinction between consumer and non-consumer RF lighting. The Commission should abandon this proposed dichotomy and seek to develop out-of-band limits that assure the public of satisfactory DARS reception regardless of whether the environment is predominantly commercial or residential.

VI. The Commission Should Ensure That RF Lighting Advocates Submit On The Record The Information Necessary To Construct Precise Interference Calculations

In considering out-of-band emission limits that allow for the development of microwave RF lighting, the Commission should develop a record that includes data on the nature of the emissions from such devices. Spectrum graphs accompanied by details as to how the data were measured would represent a good start in this process. By sharing the emissions profiles for such devices with interested parties, the Commission will be in a better position first to make interference calculations and then to assess what can be done to reduce such interference. The proponents of microwave RF lighting also should provide the Commission with information as to techniques for the suppression of out-of-band emissions. In this respect, information on filtering, shielding, and the orientation of RF lighting devices will prove useful.[33]

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[33] Orientation is important to the extent that it includes information on the pattern of RF radiation from the lighting devices. For example, if the radiation pattern is toward the zenith rather than downward or toward the horizon, emissions from microwave RF lights would be less likely to

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The Commission must also address the fact that microwave RF lighting devices pose a serious "multiple entry" problem in any interference analysis. As currently conceived, RF lighting could become quite common and many RF lights can be expected to contribute to the interference that a DARS receiver could experience. An automobile moving down a city street or approaching an intersection on an interstate highway likely would have line-of-sight propagation conditions toward multiple RF street lights, not to mention contributions from RF lighting used to illuminate commercial buildings and even areas outside of residences. Any model of the interference potential of microwave RF lighting must take such situations into account in order to develop meaningful out-of-band emissions limits.

VII. Conclusion

Simply put, there is insufficient record evidence to provide a reasonable and supportable basis for the agency's proposed rules. Under Section 18.109 of the rules, RF lighting devices will be required to avoid interference with licensed radio services. Without detailed information on filtering, shielding and orientation of emitters in RF lighting devices, it is impossible to conclude that such devices could meet this condition.

What information that does exist suggests that the proposed out-of-band emission limitations fail to account for the spectral density of the interference, and rely on a consumer/non-consumer dichotomy that is not consistent with the effects of RF lighting in the real world. As a result, the proposed RF lighting rules unwittingly could produce out-of-band emissions which severely interfere with adjacent services, including Satellite DARS, and are well

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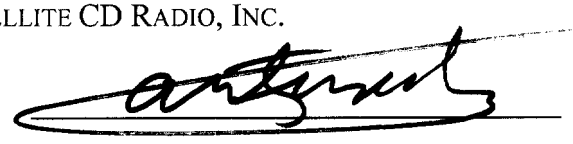
(...Continued)
interfere with Satellite DARS reception.

above the ITU's standard definition of harmful interference. Indeed, preliminary calculations suggest that the maximum interference from RF lights would far *exceed* the noise floor in the Satellite DARS link budget, making reception impossible when a mobile receiver passes in near proximity to an RF light.

In view of the foregoing, the Commission should decline to adopt the proposed rules. When RF lighting manufacturers provide more specific information on proposed devices, the Commission can issue a further NPRM proposing limits that actually will protect already authorized services, such as Satellite DARS.

Respectfully submitted,

SATELLITE CD RADIO, INC.

By: 

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APPENDIX

Technical Analysis of
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CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING THE TECHNICAL INFORMATION CONTAINED IN THIS ATTACHMENT

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in the attached Technical Analysis; that I am familiar with Part 25 of the Commission's Rules; and that I have either prepared or reviewed the technical information contained in this letter and the attachment hereto; and that it is complete and accurate to the best of my knowledge.

By: W.L. Pritchard & Co., Inc.

Wilbur Pritchard
President

Dated this 8 day of July 1998

Notary Public

My Commission Expires:

8/15/2001

TECHNICAL ANALYSIS

A. INTRODUCTION

Paragraph 8 of the NPRM states that a high power R.F. lamp has recently been developed for commercial applications that operates in the 2400-2500 MHz (2450 MHz band), that is stated to produce a spectrum closely matching that of the sun. Without adequate protection being taken, it can be assumed that a significant amount of energy could be radiated in the 2310 to 2360 MHz band, allocated to DARS service, and for which satellites are presently under construction, and planned for operational use in late 1999. This radiation could cause unacceptable interference to the DARS services and its impact requires a detailed evaluation.

Paragraph 12 of the NPRM proposes radiation emissions limits above 1 GHz for R.F. lighting products identical to the limits already in place for digital devices. The limits proposed are 100 microvolts per meter for non-consumer equipment and 50 microvolts per meter for consumer equipment.

B. ANALYSIS

(i) Background

While not explicitly stated in the NPRM, it appears that the new field strength limits are based on extending the Present Part 15.109 class A and B limits from their 10m and 3m field strength levels to the Part 18.305 distance of 30m by accounting for the additional spreading loss. Thus, on the basis of inverse dependence of the electric field on distance for far field distribution, we have:

	CFR Part 15.109	Proposed
• non-Consumer/Commercial (class A):	300μv/m@10m	100μv/m@30m
• Consumer/Residential (class B):	500μv/m@3m	50μv/m@30m

Interference analysis in satellite systems is typically expressed in terms of the increase in the wanted signal's noise temperature due to the interference signal. For digital satellite systems, once this interference level exceeds 6%, coordination is required between the systems with the objective of reaching a mutually satisfactory solution. The level of 6% represents an Interference-to-Wanted signal noise density ratio (I_o/N_o) of -12.2 dB. Alternate methods are also employed e.g. Carrier-to-Interference (C/I) ratios, but in all cases the interfering signal power level and its spectral density characteristics are required to be known.

It is important to note that expressing the interfering signal in terms of its electric field strength at a given point is not sufficient to determine the resultant interference impact. While this field strength can be converted to a flux density (dBW/m^2) its spectral characteristics over a reference bandwidth unit are not known, and consequently its interference effect cannot be accurately determined. In order to demonstrate the methodology and to establish a preliminary

baseline, some assumptions have been made and these will be refined once more detailed information is made available.

(ii) DARS Receive System Parameters

The DARS mobile receiver, operating in the frequency band 2320-2332.5 MHz has a receive system noise temperature of 167 K and an omni-directional antenna ranging in gain from +5 dBi to 0 dBi. These antennas will generally be mounted on automobiles and other mobile units, and nominal gain is expected to be at the +3 dBi level.

For a satellite receiver system noise temp = 167 K = 22.2 dBK

Receiver noise power per Hz = 22.2 + (-228.6) = - 206.4 dBW/Hz

For $I_o/N_o \leq 6\%$: $I_o = -206.4 - 12.2 = -218.6$ dBW/Hz

and with a relatively flat interference spectrum, in a 1 MHz reference bandwidth for $I/N \leq 6\%$

I = -218.6 + 60 = -158.6 dBW/MHz

Assuming a nominal 3 dB antenna gain, the interference at the input of the antenna is given by

I = -158.6 -3 = -161.6 dBW/MHz

(iii) Interference Determination

Depending on the specific interference scenario, the interference emission from the R.F. light source could enter either vertically or at any other angle, approaching the horizontal plane. Also depending on the distance between these light sources, multiple entries of interference may also be encountered.

Although all the information is not available at this time to compute the exact level of interference and its impact on the DARS receive signal, assumptions have been made for a typical scenario likely to be encountered. This example can be refined once more specific information is available, but at this time it serves to illustrate the level of interference should the assumptions prove reasonably accurate.

Example

Assumptions:

- light source is approximately 10 meters from the mobile receive antenna.
- the light source meets the 100μv/m at 30m as proposed in the NPRM

- the interference source has a relatively flat spectral density across the 2320-2332.5 MHz band, and

- the resolution (or reference) bandwidth is 1 MHz.

If the R.F. light field strength = 100μv/m at 30m, then, based on the inverse distance dependence of the far field, as mentioned before, at 10m from the light source the electric field strength E=300 μv/m

From ITU-R Rec PN. 525-2:

$S = E - 145.8$

where S = power flux density (dBW/m^2)

E = electric field strength ($dB(\mu v/m)$)

$S = 20 \log (300) - 145.8 = 49.54 - 145.8$

$= -96.3\ dBW/m^2$ ..... (1)

The effective receive antenna aperture area = $A_{eff} = \frac{G\lambda^2}{4\pi}$

Assuming G = 3 dBi at 2.3 GHz ($\lambda = 0.13$m)

$A_{eff} = \frac{2 \times 0.13^2}{4\pi} = 0.003 m^2 = -25.7\ dB\ m^2$

Received interfering power = -96.3 -25.7 = -122.0 dBW

Assuming this to be measured in 1 MHz, then the

interfering power density = - 122.0 dBW/MHz

With a system noise temperature = 167 K

Receive noise power = -146.4 dBW/MHz

I/N = - 122 - (-146.4) = 24.4 dB.

and if the interfering spectrum is relatively flat over the reference bandwidth, then

I_o/N_o = 24.4 dB, which exceeds the required threshold by 36.6 dB.

If the lower field strength of 50μv/m at 30m is used, following the same procedure as above, the flux density is reduced by 6 dB and the resultant I_o/N_o = 18.4 dB which still exceeds the required interference level by 30.6 dB.